Measuring Health Behavior Problems in Chinese Adolescents: Scale Development and Preliminary Validation

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Abstract

Background: Health behaviors shape health and well-being, improve life quality, and provide economic benefit. Adolescence is a life phase in which the opportunities for health are great. Adolescent health brings not only the benefits of the present but also the well-being of the future and the next generation. We aimed to develop a reliable and valid scale that was used to evaluate the health behavior of the late adolescent, namely, the senior high school student.

Methods: In this study, we conducted two surveys: For the first survey, we recruited 526 senior high school students (318 boys, 208 girls; Mage = 16.5), and the data were used for item analysis and exploratory factor analysis. For the second survey, we recruited 542 senior high school students (249 boys, 293; girls; Mage = 15.5), and the data were used for confirmatory factor analysis and internal consistency reliability analysis.

Results: In exploratory factor analysis, we extracted four factors with 23 items in all: exercise awareness and habits (5 items), master and apply healthy behavior knowledge (10 items), emotional regulation (4 items), and environment adaptation (4 items). The Cronbach's alpha values of the factors ranging from 0.863 to 0.937. A satisfactory goodness of fit model was achieved (CMIN/DF=3.18, RMR=0.04, GFI=0.90, CFI=0.92, TLI=0.91, RMSEA=0.06).

Conclusions: These results suggest that the Chinese version of the Health Behavior Scale is a reliable and valid instrument for assessing the health behavior of senior high school students.

1. Background

Health behaviors broadly refer to actions taken by individuals that affect health, disease, and mortality [1, 2]. Health behaviors [3–5] such as physical activity, a reasonable diet, not smoking, and alcohol moderation could decrease the risk of chronic diseases(e.g., obesity, cardiovascular disease, and cancer), improve quality of life, and provide substantial economic benefits [4, 6]. Although chronic diseases do not appear until adulthood, the behaviors that cause chronic diseases are usually formed in childhood and adolescence [6–8]. Adolescence was previously considered to be a relatively healthy stage of life, but studies have found that many major behavioral risk factors leading to non-communicable diseases (smoking, drinking, and sedentary lifestyle) are mainly formed during adolescence and affect forming habits that track into adulthood [9]. Other studies have confirmed that the improvement of risk behaviors in adolescence is an important way to prevent chronic diseases at an older age [10]. Health behavior in the early stages of life has an impact on health consequences in later life [11, 12]. Adolescence is a critical transitional period within the life course during which rapid physical, emotional, cognitive, and social development occurs [9, 13]. Adolescent health brings not only benefits in the present but also well-being in the future and for the next generation [14]. This generation of adolescents can transform all of our futures. Moreover, the latter phase in adolescent brain development (15–19 years) brings continued development of executive and self-regulatory skills, leading to greater future orientation and an increased

ability to weigh up the short-term and long-term implications of decisions [14]. Therefore, it is particularly important to cultivate and evaluate late adolescent health behaviors.

Currently, the research on healthy behavior focuses on adults and the elderly [15, 16]. No previous study has comprehensively assessed trends in health behaviors among Chinese adolescents. The Physical Education and Health Curriculum Standard (2017 edition) put forward the concept of core literacy in physical education and health [17]. Sports morals, health behavior, and sports ethics are the main components of core literacy in physical education and health discipline. The national curriculum standard put forward that health behavior consists of four major parts: exercise awareness and habits, mastering and applying healthy behavior knowledge, emotional regulation, and environment adaptation [18, 19]. To the best of our knowledge, there are currently no studies on health behaviors based on the curriculum standard (2017 edition). No existing validated health behavior scales based on the physical education and health curriculum standard (2017 edition) were found. The aim of this study was therefore to develop a reliable and valid scale that could be used to evaluate the health behaviors of senior high school students.

2. Materials And Methods

2.1. Original Items for Scale Development

The original items were created through group discussion, expert consultation, and literature survey to compile an item pool for the evaluation of senior high school students' health behaviors. Four sources were used for the evaluation of senior high school students' health behaviors: compiled related items based on the content in the physical education and health textbooks for senior high school students approved by the Ministry of Education and the physical education and fitness textbooks published by Shanghai Education Press; items found in the literature that relates to health behaviors in senior high school students; creatively compiled entries based on the characteristics of senior high school students and combined with the current background; and other items referenced by relevant scales.

2.2. Participants

Sample 1, used for the measurement of the preliminary scale, comprised 526 senior high school students (318 boys, 208 girls; M_{age}= 16.5) recruited from four public schools in Shanghai, located in the east of China. All the participants were recruited via convenience sampling of the adolescent students attending schools, and parents or legal guardians provided written consent for their children to cooperate with our research. Although we adopted convenience sampling, recruiting students from public schools in China could provide a representative population for this study due to the school size being able to represent most senior high schools. The data of Sample 1 were applied to item analysis and exploratory factor analysis.

Sample 2, used for the measurement of the formal scale, comprised 542 senior high school students (249 boys, 293; girls; M_{age}=15.5) recruited from four public schools in Shanghai. The data of Sample 2 were

applied to internal consistency reliability analysis and confirmatory factor analysis.

This study was approved by the ethics committee of East China Normal University (HR 095 in 2019). Written informed consent was obtained from all participants and their parents in China.

2.3. Items and scoring method

The Health Behavior Scale for senior high school Students includes 54 items. Students are required to answer according to their actual situation. Each item uses a five-level scoring method—"completely disagree", "basically disagree", "somewhat agree", "basically agree", and "completely agree"—scored 1–5 points in sequence. Except for the 5th and 8th items, which use reverse scoring, the questions are forward scoring and finally unified via coding.

2.4. Statistical Analysis

Data were entered into and analyzed using the IBM SPSS statistics 26.0 packages. The first step was to determine the descriptive statistics. Means and standard deviations were calculated for all normally distributed variables. The purpose of item analysis was to test the appropriateness or reliability of individual items in the scale. We explored the differences among participants in each item after high and low groups or to test the homogeneity of items. After the preliminary scale was tested, item analysis, validity testing, and reliability testing should be carried out as the basis for the development of the formal scale. The result of item analysis (i.e., critical ratio and homogeneity testing) could be used as a basis to filter or delete items. The third step was the exploratory factor analysis. Exploratory factor analysis is a common method used for scale development, including reliability tests and validity tests. The fourth step was the confirmatory factor analysis (CFA). The construct validity was determined via confirmatory factor analysis using IBM Graphics package 24.0.0 (2016), building the structural equation model. The model's overall goodness of fit was assessed using a combination of indices: chi-square/degrees of freedom (CMIN/DF), root mean square residual (RMR), goodness of fit index (GFI), comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). During the analysis process, the following criteria were used to determine whether the items were reasonable:

1. Critical ratio. The critical ratio is a commonly used discriminant index in item analysis. The critical ratio should be above 3.0.
2. Homogeneity test. In item analysis, in addition to the critical ratio, a homogeneity test can also be used. The homogeneity test includes the correlation between the item and the total score of the scale (item-total correlation), the factor loading of the common factor of the item in the scale, or the internal consistency reliability test value.
3. Kaiser-Meyer-Olkin (KMO). Whether the items are suitable for factor analysis can be judged from the value of the Kaiser-Meyer-Olkin statistics. According to Kaiser's point of view, when the value of KMO is above 0.90, it is marvelous; when 0.80–0.90, meritorious; when 0.70–0.80, middling; when 0.60–0.70, mediocre; when 0.50–0.60, miserable; below 0.50, unacceptable [20, 21]. In other words, The KMO statistics range from 0 to 1, and the closer to 1, the more suitable for factor analysis, the minimum recommended value is 0.6 [22].

4. Factor loading. Factor loading reflects the importance of the item to the extracted common factor, and the value cannot be less than 0.4 [23].
5. Communality. The communality is the variation in the observed variables which are accounted for by a common factor or common variance [24].
6. Cronbach's alpha coefficient. Cronbach's alpha coefficient is one of the indices used to test the internal consistency of the scale in reliability analysis. When the Cronbach's alpha coefficient is above 0.9, the reliability of the scale is ideal; when it is between 0.8 and 0.9, the reliability of the scale is very good; when between 0.7 and 0.8, the reliability of the scale is good; when between 0.6 and 0.7, the reliability of the scale is acceptable; when between 0.5 and 0.6, the scale is acceptable but very low; when below 0.5, the reliability of the scale is unacceptable. In other words, the Cronbach's alpha coefficient ranges from 0 to 1, and the closer the Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of the items in the scale [25].
7. Corrected item and total correlation. The value of the corrected item and total correlation is an index used for judging the internal consistency of the item and the remaining items. If the value is less than 0.4, the internal consistency of the item and the remaining items is low [26].
8. The Fit indices of structural equation model: CMIN/DF, RMR, GFI, CFI, TLI, RMSEA.

CMIN/DF (chi-square/degrees-of-freedom). Bentler and Bonnet suggested the CMIN/DF as an appropriate measure of model fit; it should not exceed 5 [27]. If the CMIN/DF is between 1 and 3, it means that the model fits well, and if the value is less than 5, it means that the value is in an acceptable range [28, 29].

RMR (root mean square residual). The smaller the RMR, the better, and the smaller the value, the better the fit of the model. Generally speaking, RMR below 0.05 indicates an acceptably fitting model [30].

GFI (goodness of fit index), CFI (comparative fit index), and TLI (Tucker-Lewis index). The values of GFI, CFI, and TLI range from 0 to 1; the closer the value is to 1, the better the reliability of the scale is [31]. In general, GFI, CFI, and TLI values greater than 0.90 indicate a good model fit [32, 33].

RMSEA (root mean square error of approximation). If the RMSEA is close to 0.06, we can conclude that there is a relatively good fit [34]. A commonly used rule of thumb is that an RMSEA less than 0.05 indicates a close approximate fit, while values between 0.05 and 0.08 indicate acceptable fit [32], and values above 0.10 indicate poor approximate fit [34, 35].

3. Results

The recovery rate of initial participants in the study was 100%, and the effective rate was 97%. The recovery rate of retest participants in the study was 99.1%, and the effective rate was 96%. There were no missing data in either sample. No violations of normality in total score distributions were evident. The skewness and kurtosis values for items were within acceptable limits across samples.

With the preliminary 54 items, we conducted item analysis; the critical ratio (< 3), item-total correlation (< 0.4), and factor loading (< 0.45) indicators were below the standard. According to the results of the item

analysis, the indices of Q8 (“I eat fast.”) were less than the statistical standards; thus, we removed Q8, (Table 1).

Validity was tested by KMO and Bartlett’s test of sphericity. The KMO value was 0.97, greater than 0.60, and Bartlett’s test of sphericity showed high significance (χ^2 = 230, 05786.12, df = 1378, and $P < 0.01$), indicating the existence of common factors among variables, which are very suitable for factor analysis.

In exploratory factor analysis, we removed the items with factor load below 0.5 for the next rotation. From the results of the principal component analysis using varimax rotation, four common factors with 23 items were extracted (Table 2). The first factor contained ten items and accounted for 26.6% of the variance; it was labeled “mastering and applying healthy behavior knowledge”. This domain includes disease prevention and control, safety consciousness, basic health knowledge, rational nutrition, and a healthy lifestyle. The second factor contained five items and accounted for 17.8% of the variance, it was labeled “exercise awareness and habits”. This domain includes exercise habits, exercise persistence, and exercise emotions of senior high school students. The third factor contained four items and accounted for 14.0% of the variance; it was labeled “environment adaptation”. This domain includes social community ability, adaptability, and the ability to deal with the relationship between cooperation and competition. The fourth component contained four items and accounted for 12.2% of the variance; it was labeled “emotional regulation”. This domain includes the understanding of emotions and the identification of different emotions. The details for each factor with the 23 items are shown in Table 3. The explanation rate of the cumulative variance after rotation was 70.7%, which was greater than 50%, indicating that the amount of information of the item can be effectively extracted. The Cronbach’s alpha values for each factor, as well as for the overall scale, were high, namely, 0.937 for Factor 1, 0.907 for Factor 2, 0.863 for Factor 3, 0.874 for Factor 4, and 0.958 for the overall scale, suggesting good reliability and high internal consistency for each factor and the scale as a whole.

In confirmatory factor analysis, the four-factor health behavior structure model was found to have an acceptable fit to the data (Fig. 1), since the RMSEA value (= 0.06), was below 0.08, CMIN/DF (3.18) was below 5, RMR (0.04) was below 0.05, and each of CFI (0.92), GFI (0.90), and TLI (0.91) were at least 0.90 based on the criteria recommended by Dullie [36]. Besides this, the factor loadings ranged between 0.53 and 0.88 and were significant, indicating a good relationship between the observed variable and latent variable [37].

Table 1
Item analysis summary table.

Items	Critical ratio	Item-Total Correlation	Communality	Factor loading	Substandard index	Note
Q1	14.471	0.675**	0.462	0.680	0	retain
Q2	15.197	0.647**	0.397	0.630	0	retain
Q3	14.611	0.667**	0.440	0.663	0	retain
Q4	18.284	0.674**	0.431	0.657	0	retain
Q5	16.484	0.677**	0.449	0.670	0	retain
Q6	20.324	0.719**	0.485	0.696	0	retain
Q7	16.588	0.634**	0.369	0.607	0	retain
Q8	2.372	0.028	0.000	-0.020	4	delete
Q9	19.498	0.694**	0.469	0.685	0	retain
Q10	14.354	0.678**	0.483	0.695	0	retain
Q11	13.769	0.673**	0.485	0.696	0	retain
Q12	17.451	0.642**	0.391	0.625	0	retain
Q13	17.382	0.622**	0.364	0.603	0	retain
Q14	15.877	0.703**	0.499	0.706	0	retain
Q15	20.901	0.780**	0.606	0.779	0	retain
Q16	15.048	0.645**	0.417	0.646	0	retain
Q17	13.71	0.636**	0.414	0.644	0	retain
Q18	18.059	0.647**	0.403	0.635	0	retain
Q19	19.124	0.747**	0.566	0.752	0	retain
Q20	18.998	0.723**	0.538	0.733	0	retain
Q21	15.765	0.704**	0.523	0.723	0	retain
Q22	13.434	0.678**	0.493	0.702	0	retain
Q23	17.915	0.729**	0.548	0.740	0	retain

Items	Critical ratio	Item-Total Correlation	Communality	Factor loading	Substandard index	Note
Q24	16.836	0.695**	0.482	0.694	0	retain
Q25	16.053	0.705**	0.522	0.723	0	retain
Q26	14.57	0.708**	0.534	0.731	0	retain
Q27	15.845	0.718**	0.551	0.742	0	retain
Q28	19.844	0.767**	0.601	0.775	0	retain
Q29	19.354	0.732**	0.554	0.744	0	retain
Q30	18.972	0.692**	0.470	0.686	0	retain
Q31	21.143	0.739**	0.538	0.734	0	retain
Q32	19.58	0.698**	0.477	0.691	0	retain
Q33	20.848	0.722**	0.504	0.710	0	retain
Q34	22.557	0.730**	0.515	0.718	0	retain
Q35	21.568	0.751**	0.570	0.755	0	retain
Q36	24.894	0.800**	0.623	0.790	0	retain
Q37	20.409	0.761**	0.596	0.772	0	retain
Q38	16.939	0.699**	0.508	0.712	0	retain
Q39	18.083	0.733**	0.556	0.745	0	retain
Q40	19.92	0.780**	0.616	0.785	0	retain
Q41	16.93	0.739**	0.573	0.757	0	retain
Q42	19.087	0.731**	0.541	0.735	0	retain
Q43	18.462	0.725**	0.548	0.740	0	retain
Q44	14.275	0.650**	0.437	0.661	0	retain
Q45	21.102	0.758**	0.583	0.763	0	retain
Q46	23.211	0.713**	0.480	0.693	0	retain
Q47	21.854	0.735**	0.531	0.729	0	retain

Items	Critical ratio	Item-Total Correlation	Communality	Factor loading	Substandard index	Note
Q48	16.096	0.646**	0.434	0.659	0	retain
Q49	19.611	0.664**	0.422	0.649	0	retain
Q50	16.354	0.673**	0.474	0.689	0	retain
Q51	17.8	0.691**	0.477	0.690	0	retain
Q52	18.835	0.673**	0.452	0.673	0	retain
Q53	20.228	0.656**	0.400	0.632	0	retain
Q54	18.6	0.704**	0.502	0.709	0	retain
Judgement criterion	≥ 3.00	≥ 0.400	≥ 0.200	≥ 0.450		

Table 2. Exploratory factor analysis result.

Item	Component				Communality
	Factor1	Factor2	Factor 3	Factor 4	
I will actively try my best to prevent all kinds of diseases.	0.796				0.743
I have the awareness and ability regarding security precautions.	0.789				0.749
I understand the harm, routes of transmission, and preventive measures of infectious disease.	0.784				0.723
I have a comprehensive grasp of methods of self-protection and mutual protection in exercise.	0.716				0.717
I never litter and I can garbage sort.	0.708				0.644
I understand the harm of malnutrition to health.	0.680				0.632
I know the characteristics and changing rules of psychological development during puberty.	0.656				0.623
I have good personal and public health habits.	0.626				0.580
I understand that different intensities of exercise have different nutritional needs.	0.611				0.606
I have a good sense of health and pay attention to developing a healthy and civilized lifestyle.	0.524				0.639
Even if there is no physical examination, I will still stick to physical exercise.		0.840			0.794
I have good physical exercise habits.		0.784			0.773
I can actively participate in or organize sports competitions in my class.		0.777			0.716
I know that physical exercise produces more positive emotions than negative emotions.		0.746			0.720
I can keep exercising for my favorite sports.		0.743			0.701
I can quickly adapt to a new learning and living environment.			0.805		0.796

Note: Factor 1: mastering and applying healthy behavior knowledge; Factor 2: exercise awareness and habits; Factor 3: environment adaptation; Factor 4: emotional regulation.

I have good social communication abilities.			0.778		0.774
I will take the initiative to ask my classmates to do physical exercise together in a new class.			0.712		0.720
I know that a harmonious combination of competition and cooperation will make me progress faster.			0.564		0.620
I can distinguish between positive and negative emotions.				0.761	0.844
I know depression is a negative emotion.				0.707	0.703
I have a positive, optimistic, and cheerful attitude towards life.				0.598	0.723
I understand the harm of unhealthy emotions to health.				0.518	0.695
Eigenvalue	6.115	4.105	3.223	2.811	—
Explanatory Variance	26. 6%	17.8%	14.0%	12.2%	—
Cumulative % of explanatory variance	26. 6%	44.4%	58.4%	70.7%	—
Note: Factor 1: mastering and applying healthy behavior knowledge; Factor 2: exercise awareness and habits; Factor 3: environment adaptation; Factor 4: emotional regulation.					

4. Discussion

4.1. Interpretation of the Findings

We designed and validated an instrument to assess the health behaviors of senior high school students in Shanghai, China. To the best of our knowledge, this is the first time that a health behavior scale has been developed and verified, based on the Physical Education and Health Curriculum standard (2017 edition).

Through exploratory factor analysis, we found that the reliability and validity of the health behavior scale are very good. The health behavior scale comprises four distinctive dimensions; mastering and applying healthy behavior knowledge, exercise awareness and habits, environment adaptation, and emotional regulation were extracted using principal component factor analysis with varimax rotation. This is consistent with the point of view put forward by the Physical Education and Health Curriculum Standard (2017 edition).

Because of cultural differences, the Chinese concept of health behavior is different from the interpretation of international health behavior. In China, according to the curriculum standard (2017 edition), health behavior is an aspect of the core literacy of the physical education and health discipline. Health behavior

is a comprehensive manifestation of improving physical and mental health and actively adapting to the external environment, and it is the key to raising health awareness, improving health status, and gradually forming a healthy and civilized lifestyle. Health behavior includes developing a good exercise routine, rational diet, regular rest, and good hygiene; controlling one's weight; keeping away from bad hobbies; preventing exercise injuries and diseases; eliminating exercise fatigue; maintaining a good state of mind; and having the ability to adapt to the natural and social environment. Briefly speaking, health behavior refers to all health-related behaviors, including behaviors at the conscious level and at the behavioral level. Internationally, health behaviors, sometimes called health-related behaviors, are considered to be actions taken by individuals that affect health or mortality. These actions may be intentional or unintentional and can promote or detract from the health of the actor or others [2]. Smoking, drinking, diet, physical activity, sleep, drug abuse, these are all examples of health behaviors. Concerning the definition of health behavior, the international expression belongs to the specific micro level, while the Chinese expression belongs to the abstract macro level, which contains rich content.

According to the values of RMSEA, CMIN/DF, CFI, GFI, and TLI, we can conclude that there is a relatively good fit between the hypothesized model and the observed data [34].

In summary, this is the first preliminary validation to assess the health behaviors of senior high school students. We found the health behavior scale to be reliable as a valid preliminary measure of health behaviors in this sample. It can also provide a good assessment of the health behaviors of senior high school students and provide a reference basis for physical education teachers to better cultivate the core literacy of physical education subjects. Moreover, the scale is based on the latest research issued by the national curriculum standards. Thus, this study is significant, as it makes it possible to measure the health behaviors of senior high school students. However, subsequent work is needed with additional independent data collected to gain a full psychometric validation of the health behavior scale. Validation of the health behavior scale should also be conducted in a more diverse sample.

4.2. Study Limitations

There are several study limitations to address. First is that, although we had an adequate sample size as confirmed by the Kaiser-Meyer-Olkin and Bartlett's test results, our sample was recruited from a single city, Shanghai, which may limit its generalizability to the national scale, particularly in the western rural area. Thus, the generalizability of results may be limited to some extent. The second potential limitation on generalizability is the exclusion of elementary and middle school students. Future research will expand the research sample to better cover the youth population. Besides this, we confirmed high internal consistency and reliability by yielding high Cronbach's alpha values in all four domains, as well as the overall scores, but several other components of reliability (e.g., test-retest reliability) could not be confirmed in this study. The above warrants future studies to examine these areas.

Although there were various limitations, it was possible to measure health behaviors by developing a scale for senior high school students and involving the largest number of people in a study conducted in

Chinese on this topic so far. Our scale could contribute to a further understanding of the situation among senior high school students.

5. Conclusions

Prior research on health behaviors has focused on adults and the elderly, and no previous study has comprehensively assessed trends in health behaviors among Chinese adolescents. Using 1068 senior high school students recruited from public schools in Shanghai, China, we developed a Health Behavior Scale for senior high school students. Our analysis identified four factors with 23 items, labeled “mastering and applying healthy behavior knowledge”, ”exercise awareness habits”, ”environment adaptation”, and “emotional regulation”. Therefore, our study suggest that the Health Behavior Scale is a valid instrument to assess senior high school students’ health behaviors. The scale is conducive to changing the course of healthy development, improving health literacy, and improving health equity.

6. Declarations

This study was approved by the ethics committee of East China Normal University (HR 095 in 2019). Written informed consent was obtained from all participants and their parents in China. Subject to review by the ethics committee, agree to carry out this study according to the research scheme under review.

Consent for publicationI confirm that all methods were carried out in accordance with relevant guidelines and regulations. I confirm that informed consent was obtained from all subjects and consent for publication.

Availability of data and materials: The authors confirm that the data supporting the findings of this study are available within the article.

Competing interests: The authors declare no conflict of interest.

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Figures

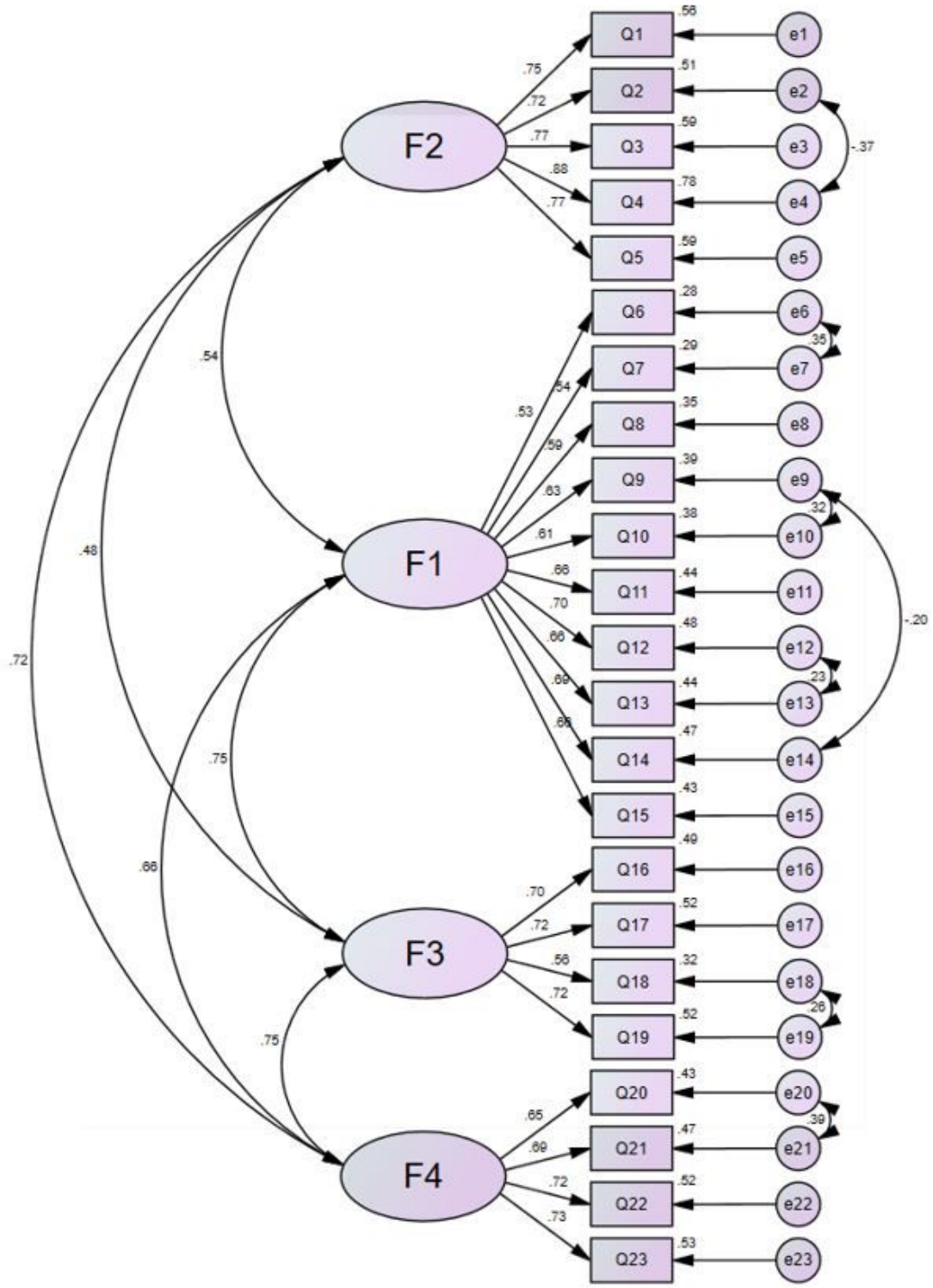

Figure 1

The structural equation model of health behaviors.

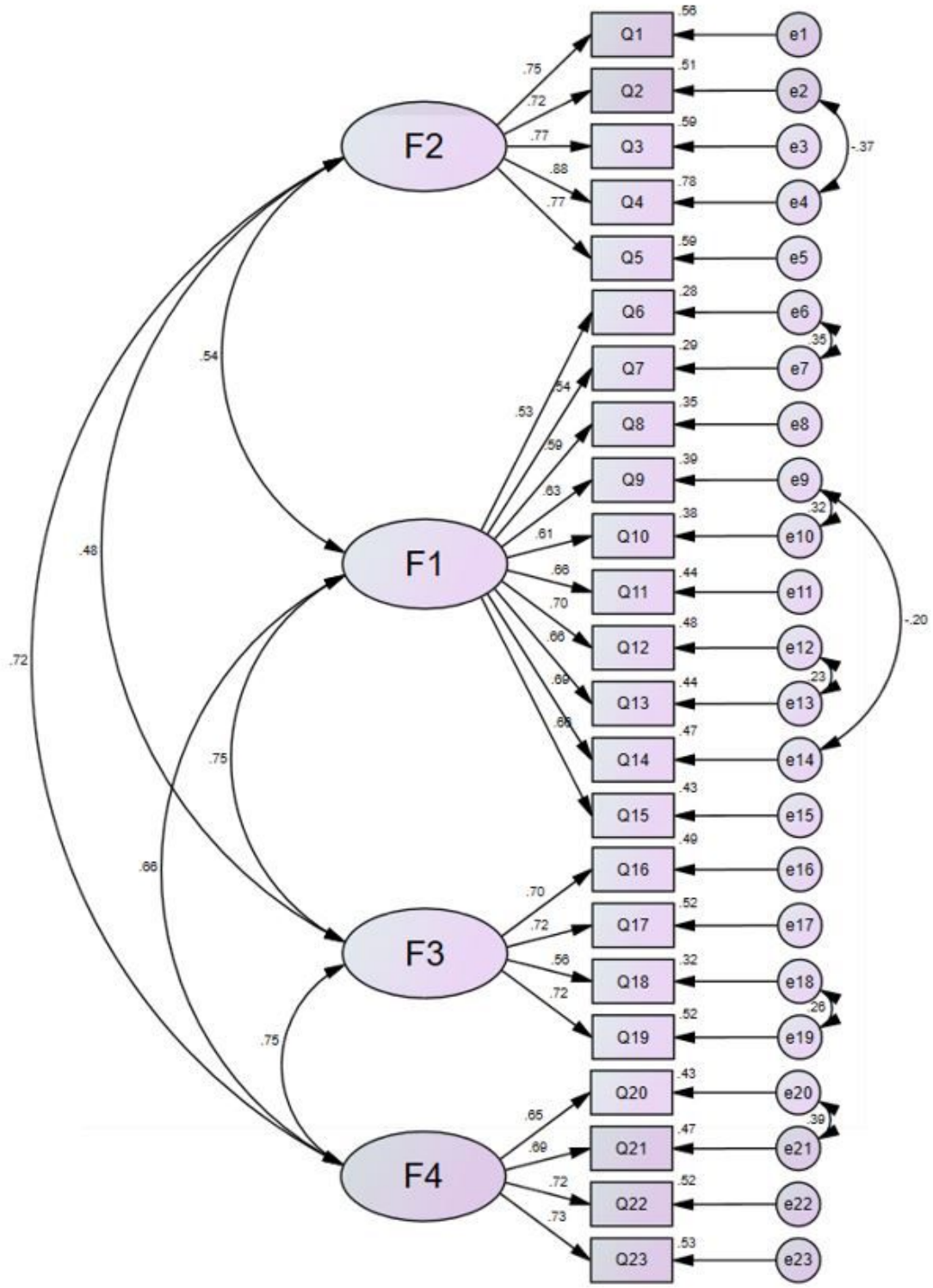

Figure 1

The structural equation model of health behaviors.

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- AdolescentsHealthBehaviorScale.docx
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